

Pano Logic Zero Client Reference Architecture Overview

Pano Zero-Client:

1. No CPU processing
2. No local storage
3. No local OS, software or drivers
4. No firmware upgrades
5. No endpoint configuration
6. No 3rd party license/royalty fees
7. Less than 5 watts of power

The Pano Device, referred to as a Zero Client, is the heart of the Pano System. Our Zero Client is a compact, purpose-built desktop virtualization hardware endpoint that connects the end user's display, input devices and other USB peripherals to the Desktop Virtual Machine (DVM) running on a virtualization server in the data center. The Pano Device is referred to as a **Zero Client** because in contrast to thin client and PC endpoints, it contains no CPU, no local storage, and no operating system. As a result, it requires no endpoint management software, no patch management, no firmware upgrades, and no local operating system licensing fees or updates. The device consumes very little power and is tamper-resistant and completely incapable of storing any data locally, providing a more secure endpoint.

The Pano Logic Zero Client Reference Architecture provides all of the information a vendor needs to create Zero Client-based products. The full Reference Architecture is available from Pano Logic for qualified vendors.

Zero Client = Total Centralization

As a Zero Client, the Pano Device contains no USB, display, or audio drivers. Instead, it links directly to the native drivers (such as, USB, audio, and display) in a Windows operating system running in the connected DVM, simply coordinating communications between the DVM and the ports on the Zero Client, much like a PC system bus or chipset. This communication is by virtue of a bus level protocol that requires no processing at the endpoint.

By eliminating all configuration, computation, and management of the endpoint, the Zero Client architecture allows for 100% centralization of VDI configuration, computation and management in the data center. In a Zero Client System, all VDI services – including DVM management, Device Discovery, Authentication, Session Brokering, Change of Control, Windows driver support, storage IOPs, and more – are handled in the backend data center. Hence, a very simple endpoint, i.e. a Zero Client, is sufficient to provide users with access and interaction to their virtual desktop.

The Zero Client architecture uniquely eliminates the high tax associated with other endpoint solutions such as PCs, thin clients, and other vendors' "not-really-zero" clients:

- **Eliminates the management tax:** No processor, no operating system, and no local drivers means there is nothing for IT to configure, manage, or update. An untrained user can plug one in and be productive immediately.

- **Eliminates the security tax:** No ability to execute arbitrary code means inherent protection against malware, viruses, keystroke loggers, and elimination of IT time trying to secure the endpoint environment.
- **Eliminates the 3-year replacement cycle tax:** Pure hardwired logic for the device's subsystems, and no moving parts, means the lowest complexity and longest-lasting endpoint solution.
- **Eliminates the power tax:** Only 3.5 watts including keyboard and mouse, 95% less than PC deployments and substantially less than other thin and "not-really-zero" clients for VDI. Including VDI server power, power savings are over 80% out of the box, and higher with VDI power management practices.

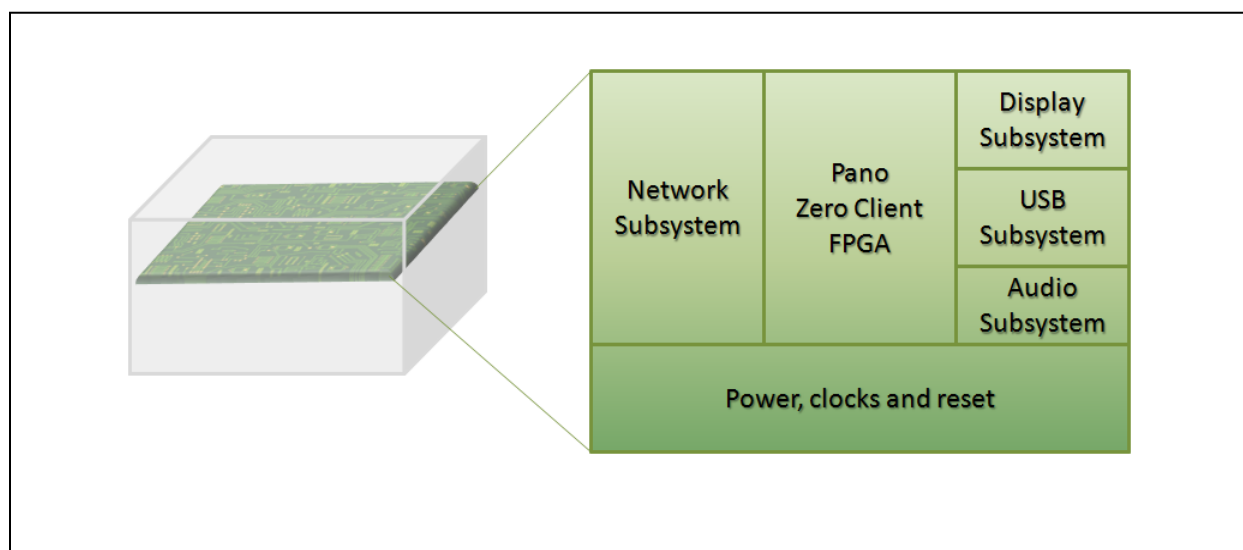


Figure 1: A Zero Client Functional Block Diagram

As shown in the figure 1 above, a Zero Client consists of following functional components:

- Pano Logic Zero Client FPGA
- Display Subsystem
- USB Subsystem
- Audio Subsystem
- Network Subsystem
- Power, Clocks, and Reset

Pano Logic Zero Client FPGA

The Pano Logic Zero Client FPGA is the heart of zero processor, zero client computing. Zero Client computing is enabled by the Pano Direct Protocol engine, which handles all functions of network connectivity and security for the Zero Client. The Pano Direct Protocol includes separate traffic flows for display, audio, USB, and Pano Button control within a single network connection.

Specifications

- Zero Processor Pano Direct Protocol Engine provides reliable delivery, advanced flow and congestion control, highly secure AES-128 encryption with public/private key exchange, and flow segmentation
- Full ARP and DHCP client support
- High-performance display, USB, and audio codecs
- Pano Button control for user access to connection management and other services

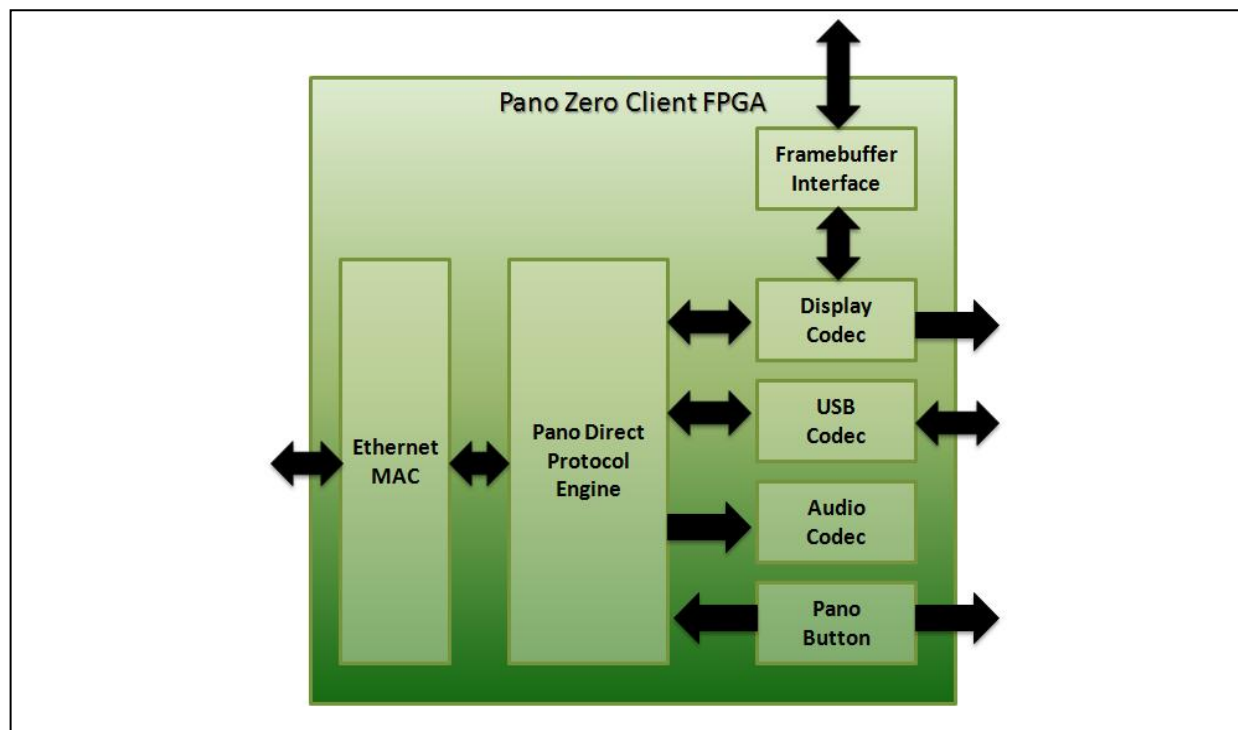


Figure 2: Pano Logic Zero Client FPGA

Zero Client Display Subsystem

The Zero Client Display subsystem consists of an external frame buffer, a high-speed video DAC to support a wide variety of resolutions, and a programmable clock synthesizer chip to generate the many clock frequencies required to support all resolutions.

Specifications

- Support for standard and widescreen resolutions from SVGA (800x600) to WUXGA (1920x1200)
- Support for wide variety of display timing modes – table lookup, CVT, standard defaults – with reduced blanking and normal blanking.
- DDC signaling for detection of monitor resolution and timing
- Built-in support for low-power monitor standby mode
- Three 8-bit high-speed DACs for full 24-bit color support
- External frame buffer holds onscreen image and offscreen cached pixel data

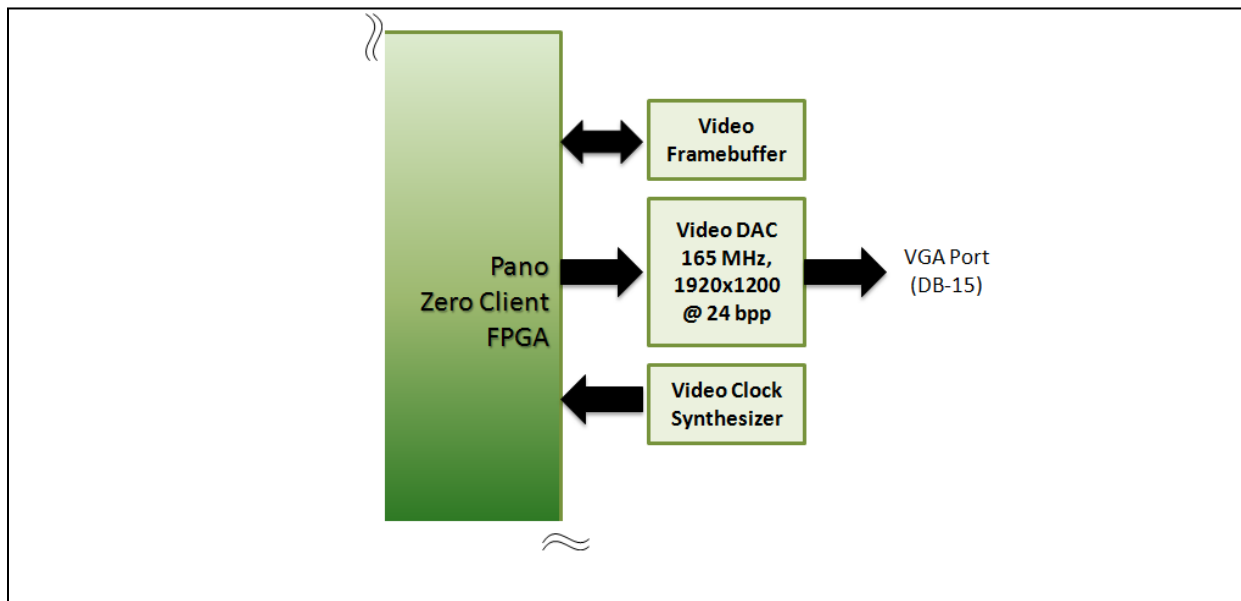


Figure 3: Zero Client Display Subsystem

Zero Client USB Subsystem

The Zero Client USB subsystem incorporates a full USB 2.0 high-speed host controller and hub enabling broad-high-performance USB peripheral support. The USB subsystem further provides unique hardware acceleration mechanisms to provide higher USB performance and interactivity than would be possible with a processor-based client. All USB drivers, even the host controller driver, run on the server at the other end of the network, enabling unmodified 3rd party and Windows-provided peripheral drivers to work with peripherals.

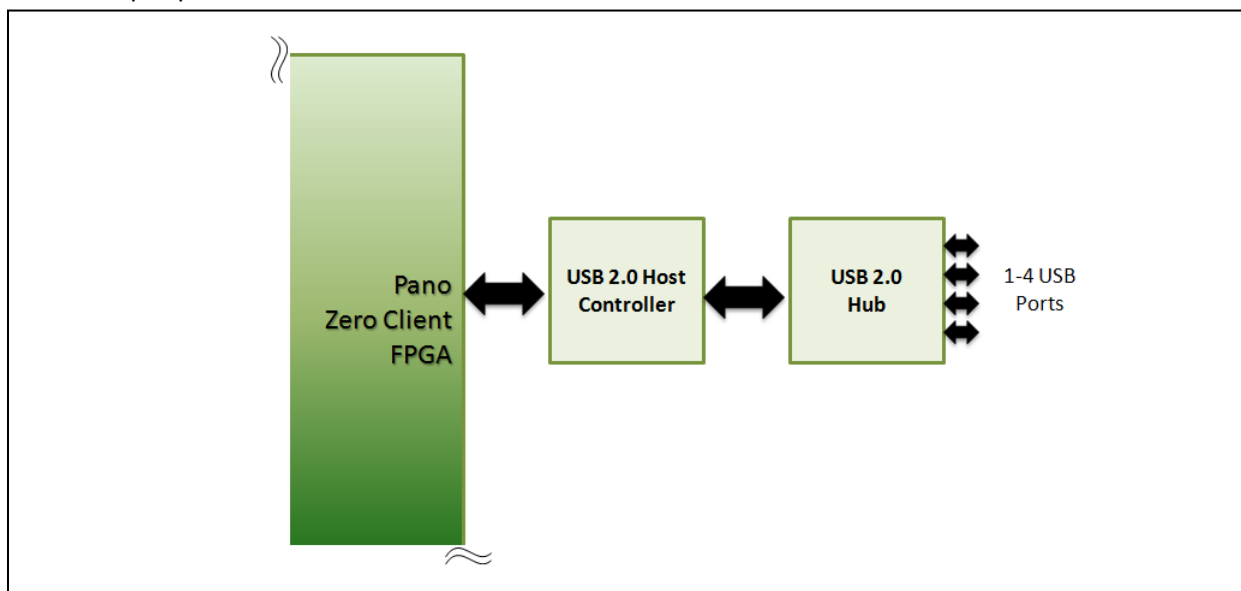


Figure 4: Zero Client USB Subsystem

Specifications

- Broad support of USB 1.1 and USB 2.0 peripherals at 480Mbps, 12Mbps, and 1.5Mbps signaling rates
- Unique server-side driver model for broadest peripheral support with existing 3rd party drivers, and elimination of all client-side software drivers
- Unique hardware acceleration mechanisms for unprecedented mouse interactivity and USB performance
- Out-of-the-box support for 1-4 external USB ports supporting high-power (500mA) devices; extensible to even more ports
- Full per-port overcurrent and power control mechanisms

Zero Client Audio Subsystem

The Zero Client audio subsystem provides audio output to an internal speaker and an external headphone jack.

Specifications

- Audio synchronization with video on the display
- 3.5mm 2-channel headphone jack driving 40mW power to 16 Ohm headphone load
- Internal speaker driven by 400mW amplifier
- 16 bits per sample audio output

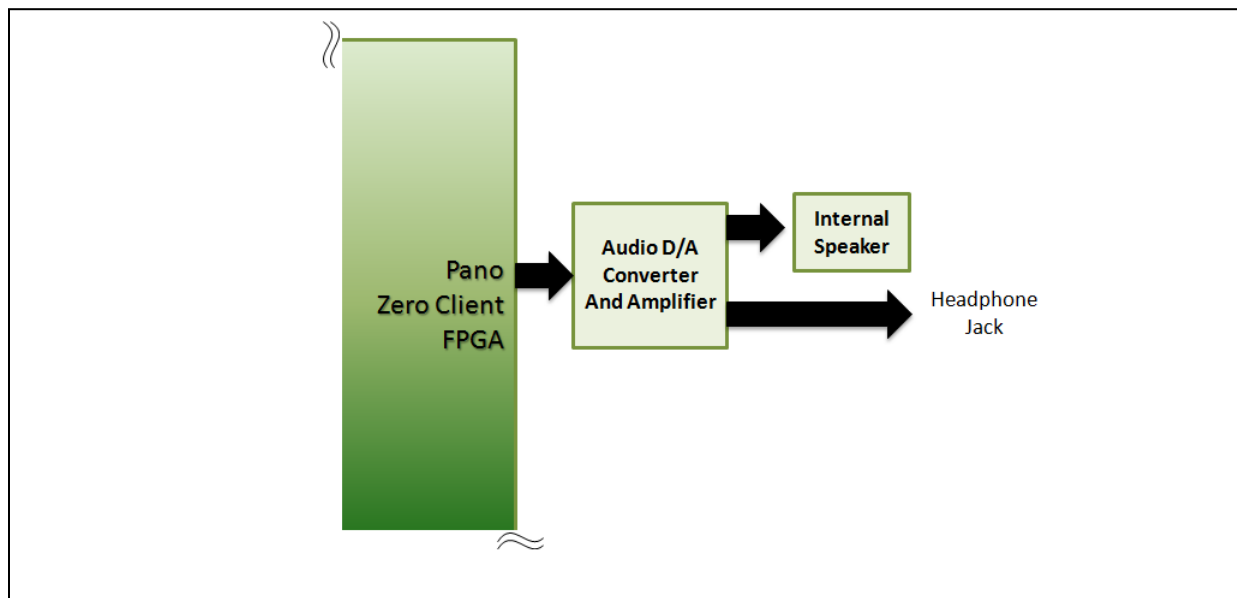


Figure 5: Zero Client Audio Subsystem

Zero Client Network Subsystem

The Zero Client Network subsystem provides a Zero Client with IP-based network connectivity. The network subsystem provides connectivity between the Pano Logic Zero Client FPGA and a standard external Ethernet subsystem for L3 and higher network protocol handling.

Specifications

- IEEE802.3 100BaseTX full-duplex/half-duplex and 10BaseT operation
- Link rate and duplex auto-negotiation and auto-crossover detection

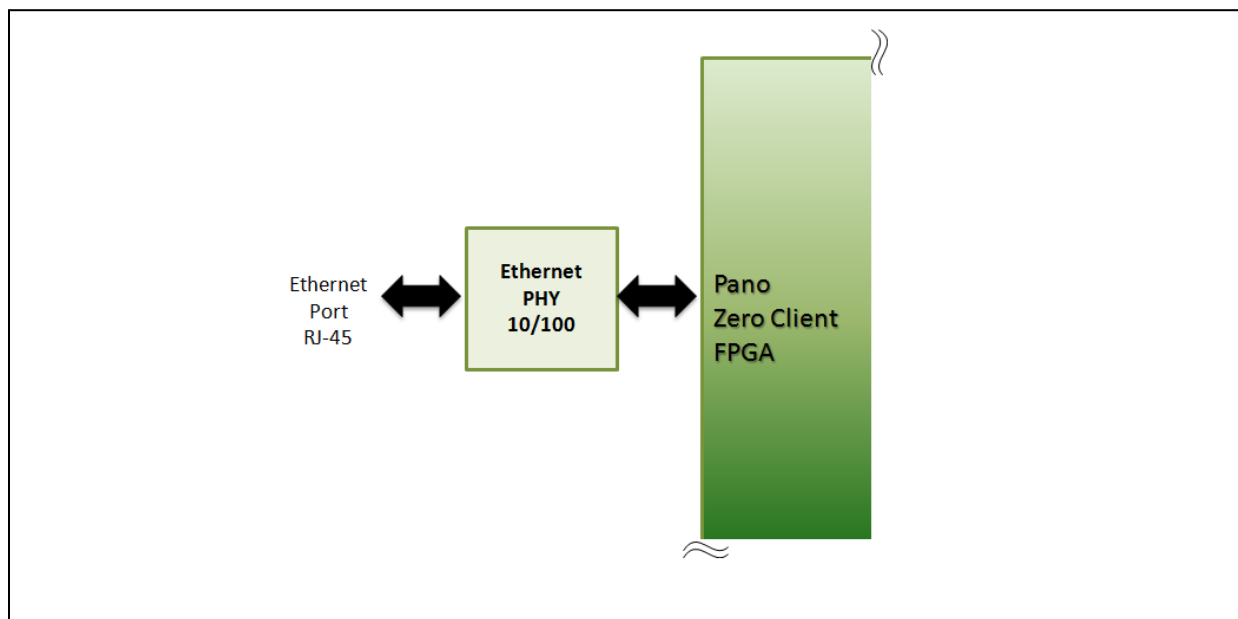


Figure 6: Zero Client Network Subsystem

Power/Clock/Reset Subsystem

The Zero Client Reference Architecture includes full specification of supporting functionality including power, clocking, and reset subsystems.

Specifications

- Ultra low-power 3.5 Watt dissipation including entire Pano Device and external keyboard and mouse
- Single low-cost 5V DC input supply Switching regulators from 5V to lower voltages for maximum power efficiency
- Reset handling and power-fault detection circuit with Red Pano Button LED fault signaling
- Clock circuitry all driven from a single root 100MHz oscillator

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